SMARTPHONE APP SafetyNex COULD REDUCE ACCIDENT RATE BY 20%

by NEXYAD

I - ONBOARD TELEMATICS AND AUTO INSURANCE : REMINDER

Onboard telematics now can measure behaviour of a driver, and therefore, car insurers have early started this adventure of connected car, more or less successfully.

The simplest applications that have been deployed are:
. locate stolen vehicles
. measure the usage of the driver, and in particular the number of kilometres travelled in order to propose adaptive pricing (vehicle that always stays in a garage will never have an accident!)

But the main business of the insurer deals with the concept of risk, and then, we have seen a lot of telematics firms proposing automatic detection of risky behaviours. The most common is the so-called detection of « severe braking », which is based on the assumption that severe braking reveals a lack of anticipation, and thereby a dangerous driving. We now know that this assumption is totally false [1], but it is still in the mind of some insurers that « want to believe » there is a simple way to classify human beings behaviours. However, the lack of results of these deployments has led some German and US insurers to abandon Telematics [2].

The company NEXYAD has demonstrated that it is possible to « measure » in real time the risk of driving, and this stimulus now keen interest in telematics among insurers worldwide. This interest was even increased as NEXYAD won the BMW Techdate Challenge with their onboard risk assessment App SafetyNex [3].
SafetyNex works where all other systems fail, simply because the problem was treated in a completely new way, without any « science fashion » consideration, especially about the deep learning (or machine learning).

Indeed, the difficulties of developing an application of efficient onboard risk estimation are :

. **Science and facts**: an accident is a rare event and inexplicable (definition: « happens by chance », a driver has got one accident every 70 000 km, on average, most of which are harmless). Observing a driver during 5 years (to make sure an accident occurred) is long and ineffective (one accident does little to make individual statistics), and variability factors of « road life situations » are extremely numerous, so it would take millions of drivers during decades before having relevant statistics.

. **Ethics**: driving behaviour in itself has absolutely no direct link with the risk [1] (indeed we conceive easily that drifting demos on an abandoned airport or just in front of a school at noon, corresponds to very different risks although the driving behaviour is the same: it obviously needs to be « contextualize »). Contextualization (that is not present in the « severe braking » experiments mentioned before) therefore demand to know, among other things, speed of the vehicle, and where this speed is practiced. But as digital maps have all recorded the maximum authorized speed, then if you record the speed and geolocation in a cloud... it potentially saves violations of speed limits. In many countries, including France, it is prohibited to record infringement to the law by non-accredited organizations (like Insurance Companies). This totally disqualifies telematics boxes that record raw data in the cloud ! However, some European insurers continue to test this kind of solution in the hope (du in vain) that the « deep learning » and « data scientists » give their risk scores. But in any case in France (40 million vehicles market), the violation of the Penal Code is sanctioned and generally pursued by the CNIL [3 bis]. And insurance companies won't have the opportunity to defend themselves saying « there is no choice » because **SafetyNex** estimates risk of driving without recording ANY confidential data! And it was shown that **SafetyNex** delivers every needed data to insurance companies (without any violation of **driver's privacy**).

We can see with these two constraints that the solution of « big data statistics in the cloud using machine learning » cannot be applied:
. statistics (or deep learning etc.): accident is rare so it won't work at the individual level
. in the cloud: this is contrary to the laws that protect privacy of people.

II - HOW SafetyNex SOLVES THE PROBLEM OF « DEEP LEARNING » DISQUALIFICATION FOR INDIVIDUAL DRIVING RISK ESTIMATION?

The accident is a rare event (1 accident every 70 000 km on average and mostly minor).

This means that one must observe tens of thousands of km to observe ONE accident... so to observe million accidents (for statistics, you need millions of data), one must observe a huge number of kilometres travelled... And in every place (because one area may be dangerous because of the presence of ravines, another one because many roads intersect, etc... it's never the same).

And as the observation of an accident is not enough, we must record all the measurable « variables » or « factors » (speed, acceleration, etc.) that describe the behaviour of the vehicle at the time of the accident (in order to « explain » the accident as say the statisticians). Of course, nobody has millions of observations of accidents at each location of the infrastructure, then statisticians will just tell you « not enough data ».

What is the impact of insufficient volume of data on deep learning [4]? Well let's take an example: Let's record for one person during 5 years (the time it take to get an accident), the day of the week, the time slot, and driving signals (speed, acceleration, braking, etc.). The result of this observation of 5 years (it's long? isn't it?) will lead on average to 99 999 km without accident and 1 km where an accident occurred. Let's say it was a Thursday, at 15:00, the vehicle was traveling at 100 km / h, etc.
As the vehicle drove frequently slower and faster than 100 km / h, the influence of the speed in the deep learning will be close to zero. However, the driver has never had an accident on Monday, Tuesday, Wednesday, Friday, Saturday, Sunday. Certainly, it has led many Thursday without accidents, but the only day he had an accident was on Thursday: the probability of having an accident on Thursday is therefore greater than that of having an accident the other days. Here is what data analysis, statistics, or deep learning will conclude.

Everyone can understand that this conclusion is completely wrong, and that it you observe that same driver for thirty years (the time to get several accidents), then you will see that the day is not a key factor (it can have an influence if traffic varies with day, but obviously it so possible to have an accident any day of the week!).

As a conclusion let's keep in mind that It's easy to make global statistics of accident on a large population (France, Europe, USA, ...hundreds of million people). But at the individual level, it is not so easy. But the goal of onboard telematics is precisely to estimate a risk, at the local and individual level!

We know it seems obvious when we say that it is not possible to study rare events without prior knowledge using data oriented mathematical methods (because there are few data and because those methods refer to the « law of large numbers »). But it's better to say it because it is apparently not obvious to everybody (and it sounds always « cool » to tell your boss and your friends that you work on a deep learning application ! ^^).

SafetyNex circumvented this problem by working in a much more rational and finally "classical" way, using knowledge and risk evaluation methods already validated by experts of accident.

Note: To develop the theory of relativity, Albert Einstein did not record hundreds of billions of data to feed a deep learning system that automatically found the law E = mc2. He used the knowledge of physicians, and inference methods of mathematics that have led to this formula. And then, in order to validate this formula, experimental physicists have performed hundreds of experiments. It is exactly this approach that has been applied to develop **SafetyNex**: there are dozens of experts working on road infrastructure "risk diagnoses." NEXYAD worked in contact with these experts for 15 years (through collaborative research programs PREDIT [5]) and developed **SafetyNex** which is a "knowledge-based system" [6], validated a posteriori on about 50 million km. These experts work the same way than industrial risk experts in factories with methods like FMEA [7].

The difficulty of developing a tool like **SafetyNex** lies not the "technology" (gradual knowledge based system and possibility theory) because hundreds of startups in Silicon Valley (for instance) perfectly know these techniques, but it resides in the extraction of deep knowledge of dozens of experts (that not always agree with each other, etc.). This extraction was made possible thanks to the collaborative French National Research PREDIT projects « Arcos » and « Sari ». This research showed a key concept in accident: the "near accident" or "quasi accident" [8], a more regular notion than accident (And therefore a notion that can be studied mathematically). Basically, if you put your feet in the water and strip the electric wires of the light of your celling, you are 100% in state of near-accident. Note that you can do so without being electrocuted. It is the repetition of the act that eventually, randomly, will cause electric shock.

This concept is particularly interesting for the insurer because it measures the RISK THAT THE INDIVIDUAL TAKES, out of luck or bad luck consideration. It is exactly what the insurer needs to know. And it is completely knowledge based : IF you put your feet in the water AND… THEN you are 100% in near accident case. You do not need deep learning, you "know": **SafetyNex** works like this.

The advance of NEXYAD on this subject is so huge because extracting knowledge of dozens of experts in road safety in Europe, gathering experts when they disagree, etc... is an incompressible duration, whatever the financial strength of the company who wishes to do it. **SafetyNex** applies about 5000 cause effects rules, and is usable WITHOUT DELAY: no observation period or learning period, when the driver starts driving with **SafetyNex** you know the risk he/she takes at every moment.

Among these high-level expert knowledge is included the fact that 75% of accidents [9] are due to inappropriate speed of the car to the danger of infrastructure. Everything other factors (poor visibility, not compliant inter-distances, rain, etc...) are important, of course, but they explain 25% of the variance of the phenomenon. When comparing **SafetyNex** to the work of the entire automotive industry (driver assistance systems with obstacles detection, etc.) we can see that NEXYAD is the only partner who offers a tool that copes with main factor of accident. All others are within remaining 25%.

III - HOW SafetyNex SOLVES THE PROBLEM OF RESPECT FOR DRIVER'S PRIVACY?

Risk estimation in driving requires having contextualized synchronized data : how the driver drives, and where it takes place.

Now, as we have explained above, the recording of those data is in contravention with driver's privacy because when you know how fast a vehicle drove and where, you just have to read the speed limit on a regular electronic map, and then you know every infringement. Is it the job of the police, not of insurance companies.

And note that, on the one hand it is forbidden to record such data in many countries, but on the other hand, it is totally unnecessary to [10] insurer. So it shouldn't happen !

SafetyNex bypasses this difficulty by performing all risk computing locally on the smartphone microprocessor, so that no indiscreet data is recorded on the cloud. Raw data are indiscreet: they may let easily know if you cross speed limits, but it also let know who you visited, when, etc. They are needed to compute a risk. So the only solution is the **SafetyNex** solution: raw data are used locally to compute the risk, on the microprocessor of the smartphone, and those raw data are NOT recorded in the cloud. Only risk statistics are recorded.

This technology differentiation allows **SafetyNex** to be the ONLY system that respects legal restriction to data recording (like in France for instance) and also the rules of elementary ethics, and the proper respect for the privacy of drivers (even without law considerations, spying drivers does not match values of NEXYAD).

IV - REAL TIME ALERT FOR THE DRIVER: SafetyNex AS A « DIGITAL COPILOT »

Note: the time latency can be guaranteed by NEXYAD because the computing are performed locally. Indeed, an App that would send and read data on the cloud could not guarantee latency (it would depend on the network connection bandwidth, and this is very variable). **SafetyNex** is then also the ONLY risk assessment App that is a real time application made to help the driver while driving (it is not only an App for the Insurance Company).

As soon as the driver approaches an infrastructure with a speed showing that he/she did not understand the difficulty of the road, then **SafetyNex** warns a few seconds before danger in order to let the driver slow down. It may save driver's life!

SafetyNex is not just a data collection tool for the insurer, it is also a useful tool for the driver, likely to save his/her life and at least to avoid causing accidents.

So using **SafetyNex** is a win win process: valuable for both insurer AND driver!

V - SafetyNex EXPECTED EFFECT ON REDUCING THE NUMBER OF ACCIDENTS

The driver who uses **SafetyNex** as "co-pilot" gets warned ahead of a danger zone, and he/she has time to slow down. That means that some accidents can be avoided with this alert.

To quantify the expected impact of **SafetyNex** we refer to road safety studies in the USA and Great Britain, which have estimated that 1 mph (miles per hour) speed reduction corresponds to 5% of accidents avoided, and fairly linear way as a large range of [11] speeds.

SafetyNex warns the driver at least 2 seconds before the difficulty. This period is the one corresponding to the legal inter-distances and this term was chosen because it lets time for a driver to detect an alert, plan, and execute an action (braking for instance).

We make average assumptions:
. It takes 1s to the driver to react, and then the driver can slow down during one second
. the driver brakes to 0.3g (*) deceleration : this is a precaution assumption. A new vehicle may slow from 1 to 1.2 g on dry surface, and 0.7 g on wet road. The standard of ADAS (Advanced Driver Assistance Systems) for a safe stop (without emergency) of an autonomous vehicle is 0.5 g. But defective old vehicles and some shy drivers slow down at 0.3 g for the deceleration feeling scared when deceleration is too brutal and then stop braking when it is too strong.

(*) g is the acceleration of gravity, 10 m / s^2)

With these assumptions, we obtain decrease of speed of 6.7 mph and integrating that **SafetyNex** only address 75% of accident, we get then that **SafetyNex should reduce accident rate by 20% !**
This is huge and only **SafetyNex** allows it.

In addition to the reduction of accidents rate, in cases of accidents that cannot be avoided, the speed at the moment of impact is reduced, which statistically reduces the loss ratio: repair costs, injury severity, mortality. These loss effects are currently being assessed by NEXYAD, still relying on the state of the art, and the data that insurance companies may provide.

VI – USAGES OF SafetyNex BY INSURANCE COMPANIES

Data recorded by SafetyNex on the cloud are histograms (profiles) and all crossings of variables:
. usage of the car : kilometres travelled, city / highway / motorway, time slots, geographical area (shires, districts, …)
. risk, class of risk
. Eco driving (optional)
And all crossings between these data.

The main usages of SafetyNex by insurance companies are: [12]

- **Increased operating margin of the insurer**: SafetyNex can reduce accident rate by 20% according to studies published in Great Britain and the USA. If the insurance company deploys SafetyNex without changing premiums : policyholders get a digital co-pilot that helps them to avoid accident, and Insurance Company sees gets less accident to pay for. Moreover, non-avoided accidents happen statistically slower (because the driver is warned upstream, he/she has time to slow down), the loss ratio is lower. This applies to all drivers, including young drivers that are costly to insurers. This is a simple and very efficient win win application of SafetyNex (no need to change actuaries pricing, no need to change anything if the insurance organization).

- **Pay as you drive**: the usages are plotted (km travelled, type of infra City / Highway / Highway, time slots, etc...) allowing to offer per-use pricing.

- **Pay how you drive**: the risk taken by the driver is estimated, and this allows the insurer to adjust its client segmentation and its prices to offer prices modulated by the risk.

- **Ecological bonus**: SafetyNex incorporates an optional eco-driving estimation system that is inversely proportional to the brutality of driving.

- **Prevention**: the risk profiles can be crossed with risk cases (inappropriate speed on crossing road, or on pedestrian zones, etc.) so it is possible to provide sensitization, training courses, and communication on a population.

- **Silver coaching**: risk monitoring can be made on the long term. And it may detect a decline in driving ability among seniors, for instance. In such a case, the insurer may intervene to help its customers to lower their risk while staying as long as possible a driver.

- **Support**: in case of severe shock, the smartphone offers a "big button" OK for calling in one click a phone number pre-recorded by the App.

VII - REFERENCES

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